A RULE FOR TESTING TAX VALUATIONS OF RAILROADS

I

The difficulty of determining the market value of a railroad for taxation under an ad valorem system is so great that any additional device for testing the fairness of valuation may be of interest. The investigations recorded in this article were conducted with the object of determining whether a mathematical rule could be used to assist in establishing the fairness of valuation.[1] The possible use of any such rule would be limited, but the results would be fairly definite within a certain scope. No attempt is made to set up a rigid and inflexible formula, to be applied to the exclusion of independent judgment. The rule is to be used, rather, to supplement knowledge obtained in a more direct way. The investigations were confined to the roads of one state, Wisconsin, though the rule proposed may be capable of wider application.

Under the law as it stands on the statute books of Wisconsin,[2] railroads pay the true average rate of taxation on the market value of the property—the amount that could be obtained for the property at a sale taking place under normal conditions. There is no need of enlarging upon the difficulties of arriving at the correct value of the property; the defects of the various methods of commercial valuation are too well known to need comment.[3] It is apparent that true value cannot be ascertained by any simple method or rule of thumb. In practice the tax commissioners make estimates independently, and while each one takes into consideration practically the same elements, no two of them give the same weight to any one of the elements.[4]

Conditions are very diverse in the different roads of Wisconsin.

[1] This investigation was undertaken at the suggestion of Professor Thomas S. Adams, formerly of the University of Wisconsin, now of Yale University. The writer is greatly indebted to Professor Adams for help in working out the problem, to Professor Charles J. Bullock, of Harvard University, for assistance in preparing the results for publication, and to Professor E. E. Day, of Harvard, for suggestions of changes in the statistical methods used.

[2] Wisconsin Statutes, 1915, ch. 51.14.

[3] For description of methods of commercial valuation, see Bulletin No. 21, of the U. S. Census Bureau, issued in 1905, *Commercial Valuation of Railway Operating Property in the United States 1904.*

[4] *Report of Minnesota Tax Commission,* 1912, p. 204. Extracts from hearing before Wisconsin Tax Commission, Madison, Wis., Dec. 14, 1911.

The physical valuation made by the engineers places the cost of reproduction of some roads as low as $10,000, while others are placed at nearly $100,000,000. There are many lumber railroads in the state along which lumbering operations have practically ceased, but which are still operated because population has centered around the road and there is a demand for a common carrier; yet the profit from operation is small. One road is operated entirely by a man and his son. One electric road is included with steam railroads because freight is transported over the road. Another road owns a ferry and a valuable terminal but practically no mileage in the state. Another has less than forty miles of road in the state, but has a valuable terminal.

The difficulty of arriving at a true estimate of the value of the roads as a whole is illustrated by Figure 1 and Figure 2, in which a comparison is made between the par value of stocks and bonds,[5] the physical valuation (cost of reproduction new), and the tax commission's latest estimate of the value of the road as a unit.

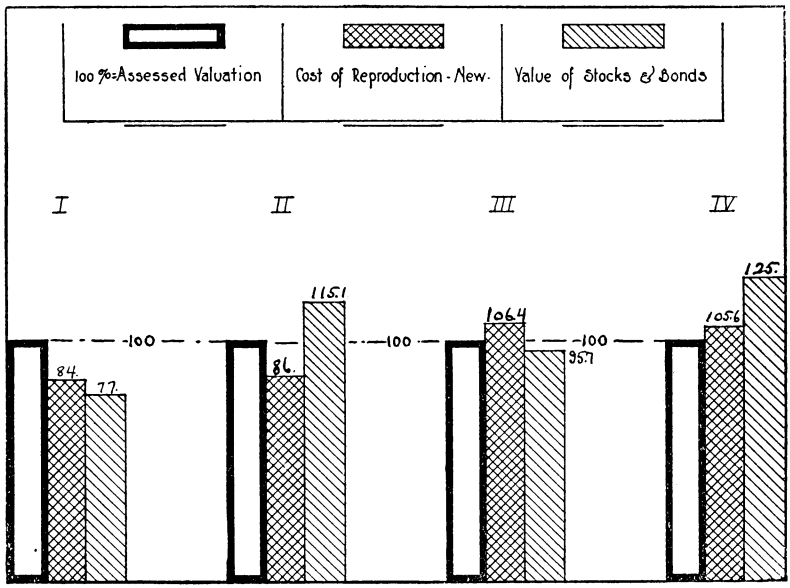

FIGURE 1.—*Comparison of the assessed valuation, cost of reproduction new, and par value of stocks and bonds of four typical large roads.*

[5] Par value of stocks and bonds is taken, rather than market value of the securities, because par value is obtainable for all roads, large and small, while the market value of the securities of small roads is often unobtainable.

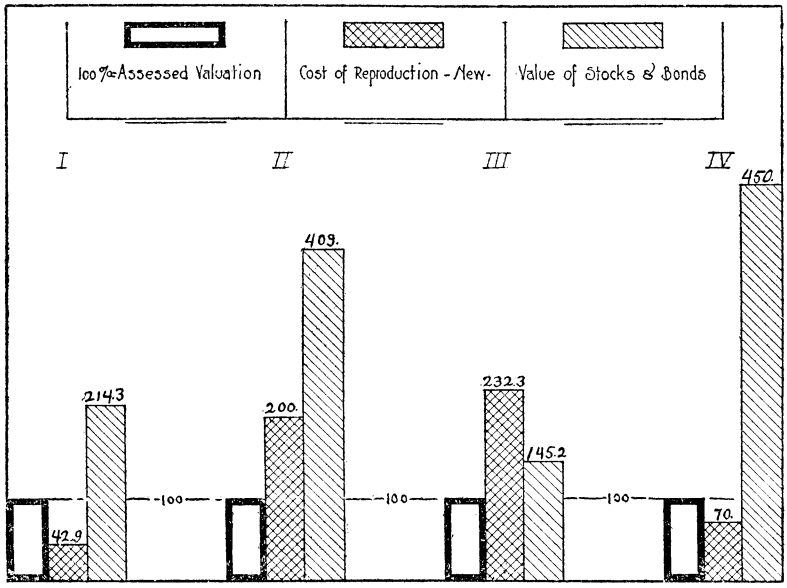

FIGURE 2.—*Comparison of the assessed valuation, cost of reproduction new, and par value of stocks and bonds of four typical small roads.*

It will be noticed that the several values more nearly correspond in the case of the large roads than in the case of the small roads, indicating that the task of the commissioners is more difficult with the small roads. The task is hard enough in every case, however, and the varying relation between book value, cost of reproduction new, and tax valuation, indicates the difficulty of securing a valuation fair between roads.

Is it possible to formulate a rule, applicable to all the roads, by which relative fairness of valuation, as between the different roads, can be established?

II

A proposal to formulate such a rule might easily lead to a long discussion of the possibility of an accurate balancing of the different elements of value. The chief purpose of this article, however, is the description of the experimental application of the proposed rule, and it seems better to state the rule as a whole before entering upon a discussion of any of the considerations which led to the adoption of the various steps designated. The rule is:

The comparative fairness of valuation of steam railroads on an ad valorem basis, may be determined in the following way:

1. Divide the roads into groups, combining in each group, as far as possible, roads of like size and similar conditions.

2. Find the total value of each group by adding together the valuations of the individual roads, as fixed by the tax commissioner.

3. Fix upon the chief factors which govern value, and determine the weight which should be assigned to each factor. In the present instance, the factors, and the weights assigned to each, were as follows:

Factors	*Weight*
1. Gross earnings—average of the five years past	20
2. Gross earnings—the year past	5
3. Net earnings—average of the five years past	50
4. Net earnings—the past year	5
5. Physical valuation	20

4. Find the percentage each factor forms of the total value of the group. That is, find the percentage of total gross earnings, on a five-year average, of all the roads in a group to the total value of the group; and find similar percentages for the four other factors.

5. Capitalize the gross earnings on a five-year average, and each of the four other factors of value of each road, at the percentage found to be true for the group to which that road belongs.[6]

6. Compute the weighted average of these five capitalized values of each road, weighting each of the five factors as above designated.

7. Determine the percentage of assessed valuation to recapitalized-and-weighted valuation for each road of each group.

8. Calculate the average of such percentages for the roads of each group.

9. Determine, for the roads of each group, the ratios of the individual road percentages to the group average. These ratios, expressed in percentage form, constitute a series of relative numbers, in which figures above 100 indicate relative over-assessment, and figures under 100, relative under-assessment.

[6] It is undoubtedly an incorrect use of the term to speak of "capitalizing" physical value. However, avoidance of the expression would appreciably complicate the statement of the rule. Since the expression is not misleading, its use seems warranted.

III

The first process proposed in the rule is necessary because the general conditions, such as the character of the territory served, density of traffic, and stability of industries, together with the fact that many of the roads were built to serve a temporary purpose, all tend toward inequality.[7] Consequently, in the present instance, the roads—fifty in number—were divided into eight groups, roads of like size and similar conditions being combined. A brief description of these groups may serve to make clearer the necessity for this part of the rule.

Group I includes the six trunk lines which furnish the main transportation facilities of the state. Two or more of these roads traverse every important section and together they have a mileage of 6608.34 miles out of a total railroad mileage in Wisconsin of 8026.32 miles, or 82 per cent of the mileage of the state. For the purposes of valuation there are no important differences between these roads.

Group II consists of a car ferry company, a bridge company, and two railroads which have only a few miles of road in the state. The situation of these companies is anomalous. The values of all depend on terminal facilities, and so they are grouped together. Mileage possesses little or no significance in the case of any of them.

Group III comprises short bits of line serving very good territory.

Group IV is a collection of roads the majority of which are entirely intrastate. At first glance these roads would seem to be important parts of the transportation system, but they are found to lack something, either in organization or in territory served.

Groups V and VI may well be considered together. All roads in both groups connect with two or more of the roads in Group I, but the roads in Group V have better connections, are about twice as long, on the average, as roads of Group VI, and serve larger towns.

The roads in Group VII each connect with only one of the roads in Group I, generally with the less important branches of those roads, and they serve poor territory.

The roads in Group VIII are almost all lumber railroads, and were built to serve a temporary purpose.

The value per mile, by groups, computed from the valuation

[7] F. W. Taussig, *Principles of Economics,* bk. VII, ch. 61, ¶ 1.

fixed by the tax commission in the year preceding this investigation, will illustrate the wide variation of conditions.

		Average value per mile
Group I	Six roads	$46,650
" II	Three roads and one bridge company	247,800
" III	Five roads	22,000
" IV	Seven roads	11,500
" V	Six roads	5,000
" VI	Seven roads	3,400
" VII	Nine roads	2,600
" VIII	Seven roads	1,800

The second process of the rule is simple. The total value of each group is found, in order that the relations which hold good for the group as a whole between value and gross earnings, value and net earnings, and value and physical valuation, may be ascertained. The necessity for this step is clear when we consider the fourth and succeeding processes of the rule.

This brings us to the third process: fix upon the chief factors which govern value, and determine the weight which should be assigned to each factor. The most difficult part of the problem is, not to ascertain which indicators of value are more reliable and which less, but to decide exactly how much importance should be

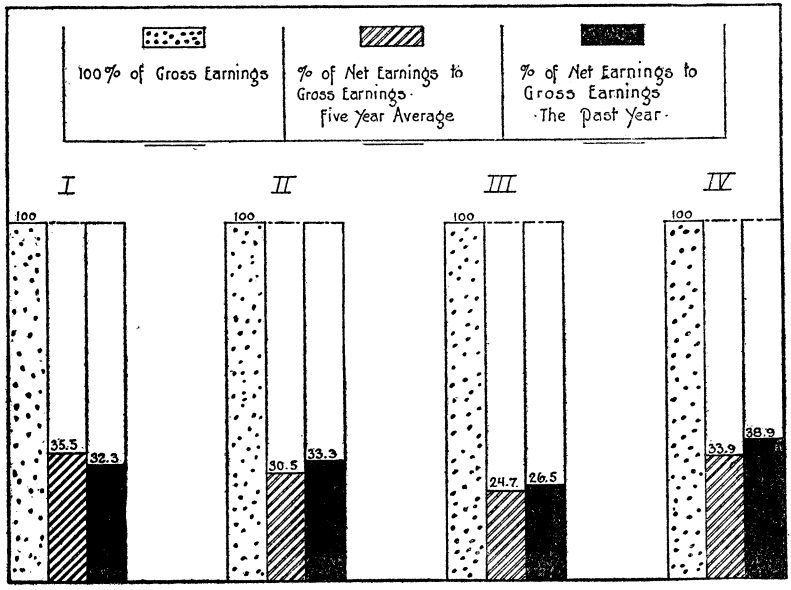

FIGURE 3.—*Comparison of the percentage of net to gross earnings, on a five-year average and for the past year, of the four groups of larger roads.*

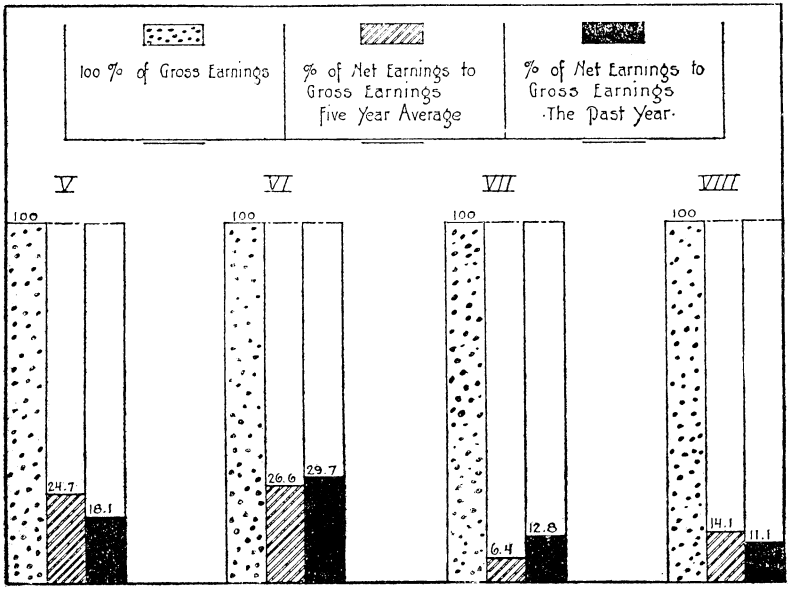

FIGURE 4.—*Comparison of the percentage of net to gross earnings, on a five-year average and for the past year, of the four groups of smaller roads.*

ascribed to each. It may be well to consider the various factors, not exhaustively, but sufficiently to bring out their relative significance.

It is not safe to use gross earnings as the sole basis, because of the disparity between corporations in the relation of gross earnings to net earnings. The inequalities that would result, if the estimates of value were based solely on gross earnings, are shown by Figure 3 and Figure 4. These diagrams show the per cent of net earnings to gross earnings. The per cent of net to gross declines noticeably from the large to the small roads.

Further, in the case of interstate roads, there is difficulty in apportioning gross earnings between states. How should such apportionment be made? There are many different methods, as, for example, the one which makes use of the traffic mile basis with a study of every waybill. Other bases are the car mile and track mileage. The method adopted may vary according to the result desired.

Several authorities, however, still give gross earnings great prominence in the method of valuation. Mr. Allen Ripley Foote has advocated the following scheme of taxation:[8]

[8] *State and Local Taxation, Second National Conference, 1908,* p. 501.

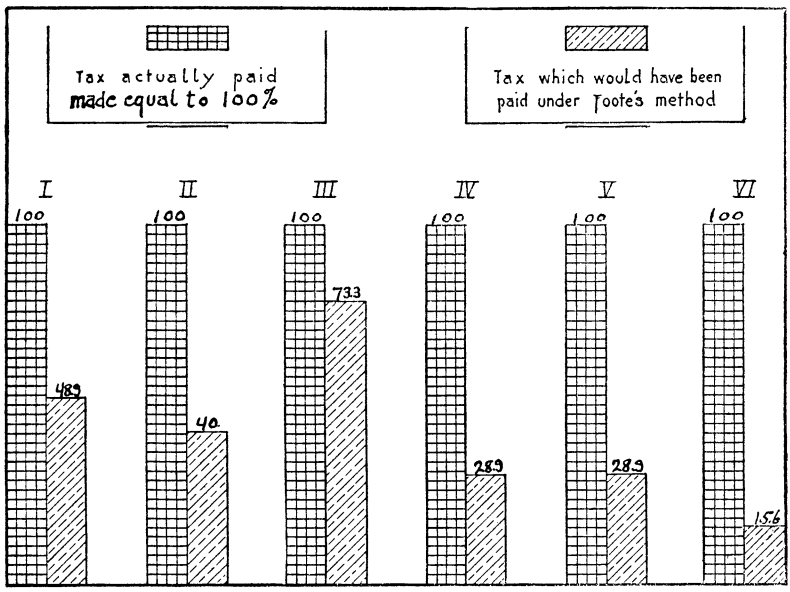

FIGURE 5.—*Comparison of the tax which would have been paid, by six of the larger roads, under the method proposed by Mr. A. R. Foote, with the tax actually paid by those roads.*

1. Assess a flat rate of 2 per cent on the gross operating revenue of all corporations, regardless of the margin of difference between their total revenue and their total operating expenses. This rate is to be paid by all corporations whose operating expenses are 90 per cent or more of their operating revenue.

2. Add a differential of 1/16 of 1 per cent computed on each 1 per cent increase in the margin of difference between total revenue and total operating expenses in excess of 10 per cent.

How does the result of this method of assessment, which places the whole emphasis on one year's earnings, compare with the results obtained by the Tax Commission of Wisconsin? (See Figure 5.) Under Mr. Foote's method a road whose operating expenses, plus taxes, were 74 per cent of operating revenues, would pay a 3 per cent tax on gross earnings. This is only slightly in excess of the rate applied practically by the commission to the least profitable roads of the state.

We may compare also the results of the method of Professor Plehn, of California, with the results of the Wisconsin commissioners' method. By using his formula,[9] Professor Plehn arrives

[9] *State and Local Taxation, First National Conference, 1907,* p. 635; C. C. Plehn, *Taxation of Public Service Corporations.*

at the gross earnings rate equivalent to any given rate of taxation on general property. The formula rests on the assumption that a public service corporation is worth what it can earn at the schedule of rates which it is permitted to charge; and that earnings, in the long run, determine the property values of such corporations. To employ this method it is necessary to know three things: (a) the average ratio of net to gross earnings of the class of corporations in question; (b) the average rate of return which investors receive who purchase corporation securities at market prices; (c) the rate of general property tax on the true valuation. Professor Plehn's formula is: The ratio of net to gross earnings divided by the rate of return to investors multiplied by the rate of the tax on true valuation equals the rate of tax on gross earnings.

The ratio of net to gross earnings of the roads in Group I is 32.3 per cent. Professor Plehn assumes 6 per cent as the average return to investors. The rate of taxation on a true valuation of general property in Wisconsin in 1912 was 1.1832 per cent.[10] Then, applying Professor Plehn's formula, we get:

$$\frac{32.3}{6} \times 1.1832 = 6.37.$$

A tax of 6.37 per cent of the gross earnings of these roads would, therefore, be equivalent to a general property tax on the full valuation.

The ratio of net to gross earnings of the roads in Group VIII is 11.1 per cent.

$$\frac{11.1}{6} \times 1.1832 = 2.19.$$

On these roads a tax of 2.19 per cent of the gross earnings would be equivalent to a general property tax on the true valuation.

Net earnings are a better guide to a true valuation than are gross earnings. Ordinarily, capacity to produce income will be the dominant factor in determining values,[11] but there are reasons why even this significant indicator should not be followed without reserve. There may be untrustworthy or inaccurate bookkeeping. Different forces may be at work in different roads. Prosperous roads may tend to minimize net earnings, while other roads, wish-

[10] *Report of the Tax Commission, Wisconsin, 1914*, p. 16. The investigation was begun in 1912.

[11] Robert H. Whitten, *Valuation of Public Service Corporations*, ch. III, ¶ 50, p. 42.

ing to make a good showing, may exaggerate them. A very unsound condition of some of the roads and extreme disparity of conditions are indicated by a comparison of net earnings with the sums actually paid out for interest and dividends. The small roads pay a very large amount of interest in proportion to earnings, or declare dividends which seem not to be justified. There is little doubt that some roads are paying "dividends" out of capital. (See Figure 6.) Then, too, exclusive taxation of net earnings

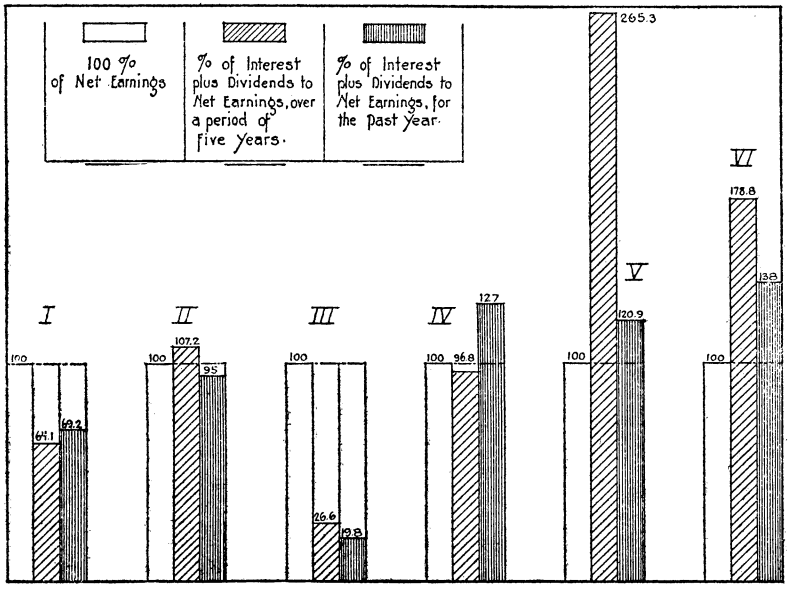

FIGURE 6.—*Comparison of interest plus dividends actually paid, over a period of five years and for the past year, of six groups of roads, with 100 per cent of the net earnings of those roads.*

would bring about total exemption from taxation in some cases in which taxable value certainly exists.

Physical valuation is not satisfactory as a sole method for the valuation of railroad property. It represents the cost of reproduction new, and a purchaser of one of the lumber railroads of the state would not give anything like the cost of reproduction for a road the value of which had largely departed with the cutting of the timber. Physical valuation is, then, only an aid in determining the market value of the property, possessing great significance in the case of the larger and more prosperous roads, but little significance in the case of some of the smaller roads.

The per cent of physical valuation to assessed valuation is greater for the small roads, indicating that they are not earning a fair return on the capital invested. The Wisconsin tax commission fixes a low valuation and the per cent of net earnings to assessed valuation is fair; the per cent of net earnings to capital invested would be a very much smaller sum.

Having considered these various factors of value, it can be asserted confidently that the factor of net earnings over a period of several years is vastly more significant than any other. It is fairly clear also that net earnings over a period of years are more significant than gross earnings and physical valuation. These considerations have governed the weighting of the several factors included in our rule. It is believed that the weights adopted are approximately correct and that, in any case, slight changes will not materially affect the result.

IV

Having grouped the roads in the above manner, determined the total valuation of each group, and fixed the factors of value and the weight to be assigned to each, the application of the rule is comparatively simple.

Following out the fourth process of the rule, the percentage of total gross earnings, on a five-year average, of all the roads in a group to the total valuation of the group, was figured; the percentage of total gross earnings for the past year, of all the roads in a group to the total assessed valuation of the group, was computed; and like percentages for net earnings on a five-years average, net earnings for the past year, and physical valuation.

Then the fifth process was performed. The gross earnings, net earnings, and physical valuation of each individual road in the group were capitalized at these various rates. For example, the gross earnings on a five-year average of each road in Group I were capitalized at the rate of 19.07 per cent. Gross earnings for the past year were capitalized at the rate of 20.25 per cent. Net earnings on a five-year average were capitalized at the rate of 6.76 per cent, net earnings for the past year at 6.55 per cent, and physical valuation at the rate of 77.60 per cent.

Carrying out the sixth process of the rule, the capitalized values so obtained were combined in a weighted average, giving the above-mentioned weights to the different factors.

Seventh, the percentage of assessed valuation to recapitalized-

and-weighted valuation, for each road of each group, was determined. It is evident that if the percentage of assessed valuation to recapitalized-and-weighted valuation is the same for all roads of a group, no road is discriminated against. For example, if the assessed valuation is 75 per cent of the recapitalized-and-weighted valuation in each case, then there is fairness between roads.

Eighth, the average of such percentages for the roads of each group, was calculated. This was done in order to secure a standard for the comparison of the percentages of the individual roads.

Ninth, the ratios of the individual road percentages to the group average were determined, for the roads of each group. These ratios, expressed in percentage form, constitute a series of relative numbers, in which figures above 100 indicate relative over-assessment, and figures under 100, relative under-assessment. When we have secured such a series of numbers for each group, we can see at a glance which roads are over-assessed and which under-assessed.

The following figures, which are merely illustrative, and not the actual figures for any group or road, will show how the method was applied. Suppose:

$500,000,000 = the total tax valuation of the roads (six in number) in any group.
95,350,000 = average annual gross earnings of the group, for the past five years, which equals 19.07 per cent of the tax valuation.
101,250,000 = gross earnings of the group for the past year, which equals 20.25 per cent of the tax valuation.
33,800,000 = average annual net earnings of the group for the past five years, which equals 6.76 per cent of the tax valuation.
32,750,000 = net earnings of the group for the past year, which equals 6.55 per cent of the tax valuation.
388,000,000 = physical valuation of the roads in the group, which equals 77.60 per cent of the tax valuation.

The gross earnings, net earnings, and physical valuation of each individual road were then capitalized at the rate ascertained to hold good for the group as a whole. For example, suppose the following to be true of Road A:

$100,000,000 = tax valuation.
94,425,000 = value (approximate) obtained by capitalizing the average annual gross earnings for the five years past, $18,006,854, at the group rate, 19.07 per cent.
93,827,000 = value (approximate) obtained by capitalizing the gross earnings for the past year, $19,000,000, at the group rate, 20.25 per cent.

96,153,000 = value (approximate) obtained by capitalizing the average net earnings for the past five years, $6,500,000, at the group rate, 6.76 per cent.

106,870,000 = value (approximate) obtained by capitalizing the net earnings for the past year, $7,000,000, at the group rate, 6.55 per cent.

87,628,000 = value (approximate) obtained by capitalizing the physical valuation $68,000,000, at the group rate, 77.60 per cent.

Combine these recapitalized values in a weighted average, giving the correct weight to the five different factors as prescribed by the rule, and the following is the result:

Twenty	times	$94,425,000 =	$1,888.50	millions
Five	"	93,827,000 =	469.14	"
Fifty	"	96,153,000 =	4,807.65	"
Five	"	106,870,000 =	534.35	"
Twenty	"	87,628,000 =	1,752.56	"
Total			$9,452.20	millions

If this total is divided by 100, the resulting recapitalized-and-weighted valuation is $94,522,000.

The original assessed valuation of this hypothetical Road A was $100,000,000. It may be interesting to compare the assessed valuations of some of the actual roads with their recapital-

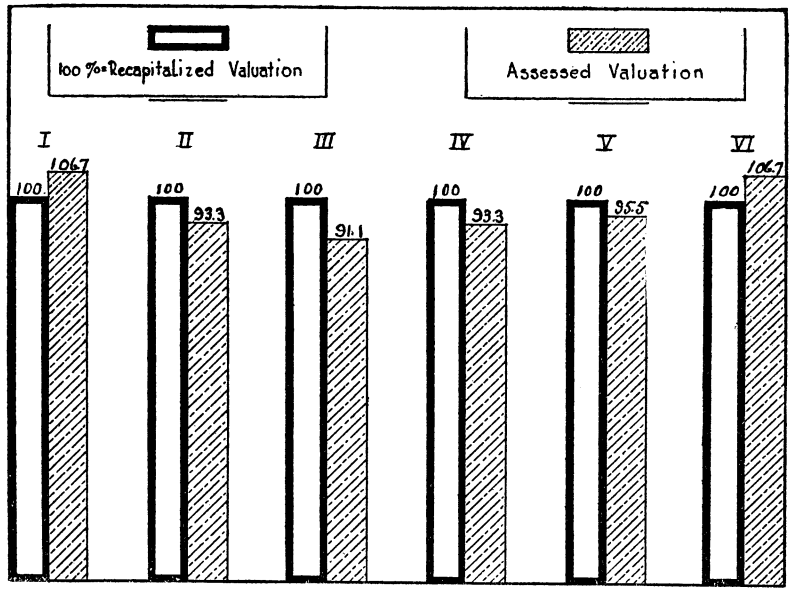

FIGURE 7.—*Comparison of the assessed valuations of the six roads in Group I, with their recapitalized valuations.*

ized-and-weighted valuations, before describing the application of the last three processes of the rule. Figure 7 gives the comparison of the assessed valuations of the individual roads in Group I with the recapitalized-and-weighted valuations. It is unnecessary to present the computations for all the groups, as Figure 7 is typical. This method was followed for each of the fifty roads of the state, except a few the data for which were incomplete.

V

The essential thing, however, in determining whether a road has been assessed with comparative fairness or not, is to find out whether the road's ratio of assessed to recapitalized valuation is greater or less than, or the same as, the average ratio for roads of that group. If it is greater, the road has been over-assessed. If it is less, the road has been under-assessed. If the ratio corresponds with the average for the group, the assessed valuation is fair. To arrive at a conclusion in regard to these facts, the last three processes of the rule were adopted.

Carrying out the seventh process of the rule, we find the percentage of assessed valuation to recapitalized-and-weighted valuation, for each road of the group. The following figures are obtained:

Percentage of assessed to recaptalized-and-weighted valuation.

	Per cent
Road I	106.7
Road II	93.3
Road III	91.1
Road IV	93.3
Road V	95.5
Road VI	106.7

Next, we ascertain from these figures the average percentage of assessed to recapitalized-and-weighted valuation for the group, finding it to be 97.8 per cent. This is the eighth step of the rule.

Ninth, we secure the ratio between each road-percentage and the group-percentage, 97.8. The figures thus obtained are:

Ratio of road-percentage to the average percentage for the group.

	Per cent
Road I	109.1
Road II	95.4
Road III	93.1
Road IV	95.4
Road V	97.6
Road VI	109.1

These ratios indicate that Roads I and VI have been over-assessed, Roads II, III, and IV under-assessed, and that Road V has been assessed at about the right amount. Figure 8 gives the comparison of the road-percentages with the group average.

My conclusion, therefore, is that a tax commission could use this rule—giving weight, as shown above, to the different factors—for

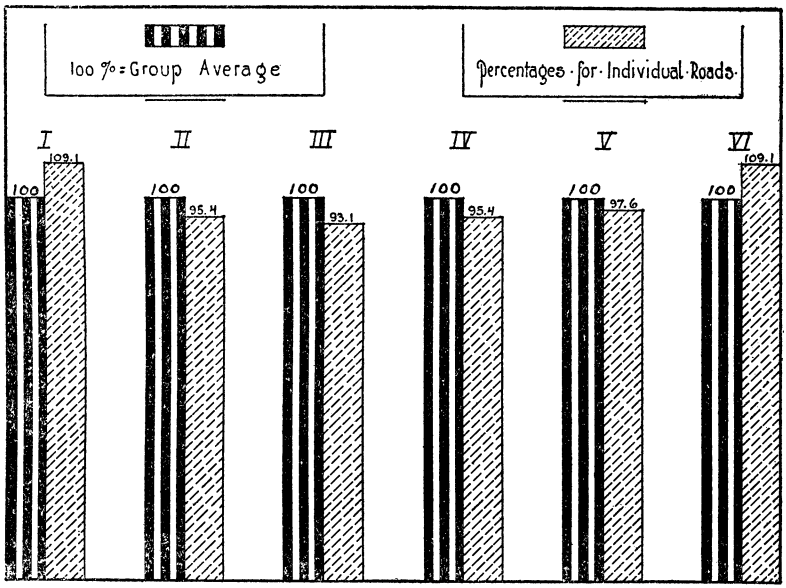

FIGURE 8.—*Comparison of the individual road percentages (assessed valuation to recapitalized valuation) of the six roads in Group I, with the average per cent for the group.*

the purpose of testing the comparative fairness of valuation as between roads in a group; such a test to be applied only after estimates of value have been established on the basis of the commission's knowledge of the condition and standing of the roads.

MARK A. SMITH.

Harvard University.